Chairman's Message

I was beginning to think winter would never end. But spring has arrived in Tennessee. I am again amazed at the rebirth of the plants. The wonderful sights of multiple shades of green foliage, the forsythia yellow spears, daffodils, tulips, crocuses, the magnificent white bouquets of the Bradford pears and the red-buds just do wonders to your sense of well being. The spectra of colors are inspiring.

It does not seem that my term as Chairman is about to expire. It only seems to have gotten started. Your Board of Directors have covered the country this year: starting in the west with the ANTEC in San Francisco, CA, to the east with the Summer BOD meeting in Kingsport, TN, to the North with the RETEC in Toronto, CN, to the South with the Winter BOD meeting in New Orleans, to the east again with the ANTEC in Nashville, TN. The new BOD structure is working well. I want to personally thank each BOD member and officer for their helpfulness and willingness to work on committee assignments this year. We could not have done it without this help. Thanks again to you and everyone's companies for allowing you to participate in the CAD of SPE.

Our upcoming Technical Sessions at ANTEC on May 5 have a good variety of topics covering color matching, colorants, instrumentation, color control review, regulatory issues and processing. Following these sessions will be our annual business meeting and budget review. I encourage each of our CAD members to plan on attending.

I remember someone saying as we advance the science of color, we are standing on the shoulders of giants. I certainly agree with them. Some of the giants I have had the privilege to know fall into four areas: 1) CAD/SPE, 2) ISCC, 3) work, and 4) church and scouting. In the CAD/SPE area I want to thank Bill Longley and George Rangos for encouraging me to get involved with the Society. In the ISCC area, I see Ralph Stanzolia and Romesh Kumar as two special people. At work, my special giants are/were: Frank Grumm, Joe Cheves (chemist), Val Daniels and Gary Edison (technicians). As for Church and Scouting, I'll always remember my Sunday school teachers Mrs. Pridemore/Corbin Lane and my fellow scout leader Ronald Williams. These are the giants that have helped and supported me through the years. Lastly, my biggest THANK YOU goes to my wife who has supported me and been my friend through the years.

Johnny Suthers

Johnny Suthers
Scientists believe they have discovered how the brain perceives color. By studying Macaque monkeys, researchers at the University of Texas-Houston Medical School have shown how modules of cells called "thin stripes" in a particular region of the brain are arranged and how they perceive colors. Daniel Felleman, a professor of neurobiology and anatomy, observed, "This finding provides the first physiological basis for the perception of the full gamut of color."

Felleman and his team mapped changes in blood flow along the stripes in the brains of the monkeys while showing them a series of colors. While looking at different colors the blood flow peaks in the brains of the monkeys shifted systematically in specific portions of the stripes. An area with a peak flow for red was next to the portion that peaked for orange, then yellow, etc. The scientists concluded that the brain uses a spatial code for color, and that the location of the peak activity within the color maps determines which color we see.

Although the research was done in Macaques, the scientists believe similar mechanisms in the human brain would work in a similar way.

- Reuters Limited news report, posted on MSNBC.com
COLOR CLASSES

The Munsell Color Science Laboratory (MCSL) is offering their annual series of Summer School of Industrial Short Courses. The classes are offered in two-day blocks. Offered for the 20th straight year is the Principles of Color Technology course taught by Roy S. Berns and Mark Fairchild. The MCSL suggests that people who are comfortable with industrial color measurement problems and solutions can jump straight into the more advanced courses. Each of these courses offers hands-on experiences that take advantage of the unique and outstanding facilities at the Munsell Color Science Lab. The offerings this year include:

TUESDAY AND WEDNESDAY JUNE 3rd AND 4th

- Principles of Color Technology
  Roy Berns and Mark Fairchild
- Device Profiles for Color Management
  Mindell Rozen

THURSDAY AND FRIDAY JUNE 5th AND 6th

- Vision & Psychophysics
  Ethbus Montag
- Instrumental-Based Color Matching
  Roy Berns
- Color & Appearance CIECAM02 & Beyond
  Mark Fairchild
- Optimization Techniques for Color Reproduction
  Noboru Obia and Mitchell Rozen
- Halftone Theory and Practice
  Jonathan Arney
IN Volvement- It’s Your CAD

Sandra Davis/ Dupont

It's that time of year again - time to vote for your Color and Appearance Division representation. The people that you elect to the Board of Directors are the people that make things happen like the wildly successful CAD RETEC's, this wonderful newsletter and other activities that have led to the repeated Outstanding Division awards won by CAD. They are the people that work behind the scenes to make it all possible for you.

Now you are thinking, "How do I make sure that the Board of Directors is made up of people that want to work to continue the success of the past?" The answer is by voting thoughtfully in the elections each year. Even though the color industry is relatively small, it is impossible for each of us to personally know every person involved. As a result, when you get the list of candidates for the Board of Directors, it is likely that you do not know all of the candidates. That is the reason that a little biographical sketch is included for each candidate. This can help with the decision making process.

As you are thinking about your options, there are several items to keep in mind. These include, but are not limited to, diversity of background, circle of contact and degree of previous involvement. One of the reasons that the CAD has been so successful is the diversity of people involved in the organization. It is important that a group like the CAD have people with a broad range of perspectives in decision-making positions. This way, the broadest portion of the membership will be represented. This diversity can come from people working in different parts of the industry - i.e., material supplier vs. equipment supplier vs. consumer or it can come from people working in different job functions - i.e., R&D vs. Marketing. A combination of people with different backgrounds will assure that the membership of CAD is best represented by its Board of Directors.

Everyone has a network that has been built through his or her career. In some cases, the network is built based on contacts made during work at a customer interface. In others, it has been developed through the series of opportunities that built the career. This network, or circle of contact, is different for each person and in it lies another strength for the Board of Directors. It is important that the people on the Board of Directors have differing circles so that more diversity can be brought to the programs of the Division.

When a person is elected to the Board of Directors, it is important that the person is interested in working for the good of the Division. While it is impossible to know how hard a particular person will work when the person is not personally known, one way to estimate the person's willingness to work is to consider the degree of involvement in the organization. Has the candidate presented papers in the past for CAD? Has the person been a moderator at a CAD conference? These are just a couple of questions that you can ask yourself.

I have outlined just a few of the factors that should be considered while deciding who to vote for in the CAD Board of Director elections. Of course, each of us will make our decisions based on our own needs, so the most important thing is that you vote. The Board of Directors is always looking for people interested in working on the Board. So, if you are interested or would like more information, please contact any of the board members listed on the back of this newsletter. This is also the first year you can vote online - please go to www.specad.org/vote.

INVITATION TO ATTEND CAD BOARD MEETINGS

The Color and Appearance Division regularly holds Technical Program Committee (TPC) and Board of Director (BOD) meetings at the ANTEC and the RETEC. In addition, a Summer BOD and TPC meeting are typically held about 6 weeks prior to the RETEC, and a Winter BOD and TPC meeting are held in early January. The Summer meeting is scheduled in various locations; the Winter meeting is typically held at the site of the RETEC that is a year and a half away. Any SPE CAD members who wish to attend are welcome at these meetings. Contact the Division President (see the back cover) for information on the location and times of any of these meetings. Please join us!
COLOR & APPEARANCE DIVISION BOARD OF DIRECTORS MEETING MINUTES

Secretary's Report
Minutes of the last meeting were approved without comment.

Treasurer's Report
The Treasurer's report was presented and accepted by the board. Bruce also reported that the annual report is due in November and he will send it electronically in the next couple of weeks.

ANTEC Technical Program Committee
ANTEC 2003 (Nashville, TN) - Ed Tucker/Bruce Mulholland
We should have sufficient papers to present a good technical program at Antec. Ed will attend the Matrix Meeting.

ANTEC 2004 (Chicago, IL) - Jim Figaniak and Sharon Ehr
No activity required yet.

ANTEC 2005 (Boston, MA) - Not assigned
Aram Terzian has agreed to assist with the technical program for this conference.

REETC Technical Program Committee
REETC 2002 (Toronto, ON) - Bob Trinklein
The conference is ready to go with the extensive work of the committee evident. The anticipated registration is about 400. The room for the papers is set up in a classroom style, which is preferred when there is sufficient square footage available. A rear projection system will be used for the speakers. There are a number of students from Terra in attendance who will assist with usher activities during the conference. All in all, everything looks good and we expect a successful RETEC.

REETC 2003 (Atlanta, GA) - Tracy Phillips
No change in the status of this conference since the August BOD. The call for papers will be publicized during this conference.

REETC 2004 (Marco Island, FL) - Sandra Davis
There is nothing new to report on this conference scheduled for Marco Island.

REETC 2005 - Earl Balthazar
Through work with the New Orleans Visitors and Convention Bureau, a number of hotels have been identified as interested, available, acceptable (space wise) and within our preferred budgetary range. Based on this information, it has been proposed that RETEC 2005 be held in New Orleans at the Fairmont.

REETC 2006 After the August BOD meeting, Cincinnati and San Antonio were investigated as potential sites for RETEC 2006. Both sites appear to be acceptable. It was proposed (and accepted) that RETEC 2006 be held in Cincinnati. Bruce Mulholland agreed to act as general chair for the conference and Scott Heitzman as house chair.

REETC Demographics
There was discussion about the demographics of the attendance at RETEC. It was recommended that an evaluation of the demographics be done. Tracy Phillips offered to look at the information for as many past RETEC as possible. It is requested that registration lists for past RETEC's be forwarded to Tracy.

Education Committee
The Career Clearinghouse continues to be active, however, most of the opportunities available are either entry level or management. Educational budgets continue to decrease, but the impact at Terra has been minimal. Terra is continuing to look for the molds that were requested at the August BOD meeting. This year, there are 8 scholarships at Terra in the coloring program and the overall enrollment in the program has increased. Northampton Community College is preparing to start on a capital improvement project. Their program advisory committee is scheduled to meet and consider the level of interest in a coloring and decorating program for plastics. There is still no information on the Coloring of Plastics book. The publisher is taking orders but there are no confirmed shipments. At the August meeting, there was a request for past ANTEC and RETEC preprints. There has been min-
COLOR & APPEARANCE DIVISION BOARD OF DIRECTORS MEETING MINUTES - continued

imal response to this request. Three potential sources of the RETEC 1998 preprint have been identified and will be pursued. Bob Trinkle will include an announcement regarding the desired preprints in the newsletter. The scheduled meeting with the Director of the Plastics Museum did not take place. There are plans to reschedule the meeting.

Newsletter Committee
An electronic version of the newsletter is under development and should be available soon. The next issue of the newsletter has been mailed and should be arriving during RETEC. This issue is the first issue since the cover has been redesigned. It is Bob’s intention to publish one more newsletter this year. Bob has also announced that he will handle the newsletter for one more year. At that point, he will have edited the newsletter for five years. He requested that the Board start seeking a replacement so that the transition can be as smooth as possible. Sharyl Reid, the new financial manager for the newsletter, reported that there are three new sponsors which should appear in the next newsletter.

CAD Web-Site
Joe is actively involved in the development of the electronic version of the newsletter. An incentive to pursue this alternative is the reduction in mailing costs. Bill Dawes has set up the CAD website to handle the RETEC 2003 registration as well as the BOD election. Since the establishment of the CAD website, Bill Dawes has been very attentive to the site and has provided excellent service to the division. It was proposed that further recognition be given to Bill for his service. Currently, the sponsorship information on the website cannot be stopped as it cycles. This will be changed so that if a user wants to get more information on a particular sponsor, the user does not have to wait until it cycles again. The number of hits on the site is increasing.

Endowment Committee
No new information to report since the August meeting.

Awards Committee
The nominations of Bruce Mulholland for Fellow of the Society and Joe Cameron and Johnny Suthers for Honored Service Member have been submitted. The final determinations regarding these awards will be made by SPE with recognition of the winners at ANTEC. The minutes from the August BOD included a detailed list of the awards to be presented at RETEC 2002. In addition to those previously announced, the CAD 2002 Outstanding Achievement Award will be presented to Sandra Davis.

Public Interest Committee
Once again, the CAD BOD will conduct a survey of RETEC attendees in an effort to gain information to better serve the membership. The return of a completed survey will be an entry in a drawing for a prize, as has been done in the past.

Membership Committee
According to the most recent report, CAD has 796 primary members that are paid in full. As a result of the change in membership policy, there are a large number of suspended memberships and the CAD roster is down significantly. According to International, all suspended members were contacted by telephone during the last week of August regarding their suspended membership status. It was suggested that when the next report is available, Bill should e-mail it to the members of the BOD for review. The BOD members may have regular contact with some of the people on the suspended list.

International Committee
The Additives and Colors Europe SIG has a conference set for February 19-20, 2003 in Antwerp with about 20 papers. The plans are going forward for a successful conference.

New Business
◆ Marcie McMurrer: The death of Marcie McMurrer was recognized. Marcie was a founding member of the SPE Polymer Modifiers and Additives Division and a long time editor in the plastics industry.
◆ Winter Meeting Location: The winter meeting will be at the Fairmont New Orleans January 20-21, 2003. (During the BOD meeting in Toronto, the dates of January 13-14 were originally selected but had to be changed due to hotel conflicts)

<table>
<thead>
<tr>
<th>Action Items</th>
<th>Assigned to</th>
<th>Complete</th>
<th>Target Completion Date</th>
</tr>
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<tr>
<td>From-August BOD</td>
<td>Joe Cameron</td>
<td>Y</td>
<td>Jan 2003 BOD</td>
</tr>
<tr>
<td>Investigate Cincinnati as a potential RETEC location</td>
<td>Scott Hertzman</td>
<td>Y</td>
<td>Jan 2003 BOD</td>
</tr>
<tr>
<td>Investigate San Antonio as a potential RETEC location</td>
<td>Brian Bently</td>
<td>Y</td>
<td>Jan 2003 BOD</td>
</tr>
<tr>
<td>Develop an outline of the job requirements for the ANTEC &amp; RETEC Chair</td>
<td>Bruce Mulholland</td>
<td></td>
<td>Jan 2003 BOD</td>
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<td>Coordination of a worst-to-review conference revenue split proposal for cosponsored conferences</td>
<td>Bruce Mulholland</td>
<td></td>
<td>Jan 2003 BOD</td>
</tr>
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<td>RETEC BOD Registration lists from past RETEC to Tony Phillips for demographic collection</td>
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<td>Jan 2003 BOD</td>
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<td>List of suspended members to BOD members</td>
<td></td>
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<td>When next list (08-02) is available</td>
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WHAT COLOR IS YOUR CHEESE?

Alright, that's a mixture of a couple of popular self-help book titles. Nonetheless, the Better Homes and Gardens New Decorating Book (available from Meredith Books for about $35) has a very interesting discussion of the emotional connotations of colors.

*Which colors make you happy? Which ones help you relax after a busy day?* The colors you surround yourself with really do influence your emotions. Colors play off your mood in three basic ways - active, passive, and neutral. These are important factors when choosing colors for a given object, area, or environment.

To stimulate conversation, for example, choose active colors such as red, yellow, and orange, which inspire camaraderie and an upbeat attitude. Yellows can inspire creativity. Passive colors, such as blue, green, and purple help pacify and restore. Neutral colors, such as gray, beige, white, and taupe help bridge other colors together. Dark neutrals tone down other colors, while crisp white intensifies them.

*What power do various colors have? Their strength might surprise you. Some clues:*

**Pink:** soothes, promotes affability and affection

**Yellow:** expands the space, cheers your spirit, increases energy

**Black:** disciplines, authorizes, strengthens what's around it, encourages independence

**White:** purifies, energizes, unifies, in combination makes all other colors stronger

**Orange:** cheers, commands, stimulates appetites and conversation

**Red:** empowers, stimulates, dramatizes, symbolizes passion

**Green:** balance, normalizes, refreshes, encourages emotional growth

**Purple:** comforts, spiritualizes, creates mystery and draws out intuition

**Blue:** relaxes, refreshes, cools, produces tranquil feelings, and peaceful moods
Aram Terzian and Eva Wright of EMD, our hosts at the RETEC Opening Reception

Earl Balthazar, our host at the Winter CAD Board meeting

Two very gracious Southerners, Sharyl Reid (Newsletter Business Manager) and Bill Dawes (CAD Webmaster)

It's just not a RETEC unless you come home with a Clariant Giraffe!

Roger Reinicker, Frank Laviere, Lynn Bente, and Tim Reilly were the first speakers at the Toronto RETEC (Frank and Lynn won the Best Paper Award)

Bob Charvat explains color theory to three lovely Terra Tech students

Your CAD Board of Directors relaxing & enjoying each other's company at dinner.
CAREER CLEARINGHOUSE

To better serve our members, the CAD Board of Directors has agreed to try an employment clearinghouse in the CAD newsletter under the following strict rules and guidelines.

You must be unemployed or have a firm separation date at the time the resume is sent. This is mandatory—no exceptions. Also, include a time limit on the availability of the resume.

Employers seeking new employees
Send your requirements by mail or fax to Bob Charvat at the above address. Indicate the length of time the new career will be available. The Clearinghouse Coordinator will, IN COMPLETE CONFIDENCE, advise either and/or both parties of any potential matches. NO RECOMMENDATION OR ENDORSEMENT BY EITHER PARTY SHOULD BE ASSUMED OR SUGGESTED BY ANY ACTION TAKEN OR NOT TAKEN BY THE COORDINATOR.

We will try this activity for a time with appropriate reviews to assess the appropriateness, efficiency, and productivity of this effort and then determine if it is worthwhile to continue, modify, or terminate it.

Robert Charvat
Robert A. Charvat

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In our next issue:
Spectrophotometer Tips

Your Company And Our Division

The Color and Appearance Division (CAD) is committed to the publishing of at least three newsletters a year (four, if there is sufficient material to justify the extra issue). To that end, we would like you to think about the financial side of sponsorship of the newsletter. For the small donation of $300 per year, we offer a business card sized (2 x 3.5 inches) mention in our newsletter, which goes out to the nearly 2000 members of the CAD as well as other SPE division members. These are people active in every aspect of plastic coloring and additive technology. Larger sized spots are available at a commensurate increase in rate.

This year we are also initiating “Hot Links” on our SPE CAD web page, located at http://www.specad.org for a fee of $300.00 per year. These Hot Links would allow visitors to our webpage to be one click away from your site!

In addition to this new service, we are also offering a discount for those who might wish to help sponsor both CAD news vehicles. The cost of a combined Hot Link/Newsletter sponsorship is $500.00 per year.

If you are interested in helping to sponsor either the SPE CAD Newsletter or the CAD Website, or both, please contact:
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EM Industries announces new company and brand name

(Paid Advertisement)

EM Industries, Inc. announced today that effective January 1, 2003 they would officially begin to conduct business under their new name EMD Chemicals Inc. A spokesperson for the company said the changes were taking place "as part of a global branding strategy being implemented by their parent company, Merck KGaA, Darmstadt, Germany, to unify and strengthen its market presence worldwide." In the USA and Canada, rights to the "Merck" name belong to the pharmaceutical company Merck & Co. Throughout the rest of the world, Merck KGaA, Darmstadt, Germany has the rights to the "Merck" name. As part of this new global strategy, Merck KGaA, Darmstadt, Germany is uniting all its NA operations under the umbrella brand EMD.

Douglas S. Brown, President and CEO of EM Industries explains, "To start with, there has always been some confusion in our markets because of the "Merck" name." EM Industries, Inc. consists of an Industrial Pigments Division, Rona - Cosmetics Business Unit, and a Life Science Products Division as well as including the business EM Science with its Analytics and Reagents Division. "As one of the Merck, KGaA, Darmstadt, Germany operating companies in NA it has been difficult for us to communicate to our customers and the market exactly who and how strong a global organization we really are", Doug continues. "Our parent, Merck KGaA, recognized the need for a more powerful, unified presence worldwide and for a visible, unified business structure in the US and Canada. As the "Merck" name has tremendous value to us in the ROW, (Rest of World), a dual brand global strategy was developed. Merck, KGaA, Darmstadt, Germany has created a new corporate logo and identity guidelines for the ROW that mirror that of our new brand EMD. The logos themselves tell the story much more quickly!"

(Merck KGaA, Darmstadt, Germany)  (EMD Chemicals Inc.)

Doug continues, "As many of our (US and Canadian) customers have global operations, these changes will strengthen not only our presence but also help us build stronger alliances with our customer base worldwide, as well as address the "Merck" name issue." The company believes they will also provide operational synergies that will increase overall efficiency and add value to all their customer relationships.

Keeping in line with maintaining a global philosophy, their Afflair® mica pigment product line, which is known as Iriodin® Effect Pigments in the rest of the world, will be changed to reflect the Iriodin® brand name. In addition, all their product descriptions will be harmonized to ensure uniformity within their product lines. The change will allow them to operate at optimum efficiencies and with no confusion in their global markets. The change is purely in the brand name. The product will remain the same. Following is the Iriodin® Effect Pigments global trademark.
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Classical Organic Reds - Introduction
Henry Ford would have been appalled and aghast if he had to deal with organic reds for coloring plastics. Unlike the Phthalocyanine Green that was discussed in the last issue, there is an abundance of reds available to the master batch formulator. In fact, there are so many that they will be covered in two installments. In this issue, the classical azo reds will be discussed; the high performance ones will be covered in the next edition.

Chemistry, History & Manufacturing Processes
The vast majority of the azo reds are characterized by the double bonded nitrogen group \((N=N)\) joining an aromatic amine to a naphthalene derivative. Depending on the substituent groups on the molecule, some of them are precipitated as metal salts forming insoluble pigments, while others are, by their nature, insoluble. The former are commonly called metalized azo reds. The structures of the metallized azo reds, commonly used in plastics, are shown in Figure 1.

![Figure 1]

The metallized azo pigments are produced by reacting the diazotized aromatic amine to the naphthalene derivative, followed by precipitation as the metal salt. Common metals used are: barium, strontium, calcium and manganese. In addition to rendering the colorant insoluble, the metal chosen affects the shade and durability of the resulting pigment. Going from the yellowest shade to the bluest one are barium, strontium, calcium and manganese. In some cases the pigments are co-precipitated with a hydrochloric acid to form a rosinated pigment. This rosination is done to increase the depth of masstone and transparency as well as improve the ease of dispersion. The final pigment is filtered, washed free of reaction salts and then dried, ground, and finally, blended to match a standard. The non-metalized azo red pigments are manufactured by the same process, but with the necesssity to precipitate them as metal salts.

Azo reds were first developed in the early part of the last century and today account for approximately 24% of the 213,000 metric ton global organic pigment market. Roughly 21,300 tons are consumed in plastics around the world.

PROPERTIES & USES
Some of the commonly used azo reds are:

**Pigment Red 48:1** - Barium Red 2B is a strong very yellow shade pigment with heat stability to 260°C. Lightfastness measures a 3 on the 1-8 blue wool scale. The colorant is easy to disperse and is used in almost all thermoplastics, excluding the engineering polymers. It has good migration resistance in poly (vinyl chloride) systems.

**Pigment Red 48:2** - Calcium Red 2B is the counterpart to the Barium Red 2B. It fills color space for the formulator by offering a clean, strong, and economical blue shade red. Physical properties are similar to Barium 2B, although the Calcium 2B has slightly better light stability.

**Pigment Red 53:1** - Red Lake C is almost identical in shade to Barium 2B. Its slightly better heat stability of 288°C permits its use in ABS (acrylonitrile butadiene styrene) where lightfastness is not important. Caution should be used in plasticized PVC as migration can occur.

**Pigment Red 57:1** - Calcium Lithol Rubine is bluer than Calcium 2B with slightly inferior fastness properties. In Europe, it replaces Calcium 2B as the blue shade red of choice. The FDA certified version of this colorant, D&C Red 7, is approved for use in coloring food contact polymers under 21CFR Part 178.3297.

Continued on page 15
ORGANIC REDS FOR PLASTICS - CONTINUED

**Pigment Red 60:1** - Pigment Scarlet is unique as it is laced using barium chloride and aluminum hydroxide. The shade is not the typical yellow shade usually offered by a Barium Lake. It is bluer, tends to be weaker but has much better physical properties than the 2Bs'. With heat stability to 300°C and mid range light stability, Pigment Scarlet offers a pigment with properties between those of high performance pigments and the above-mentioned azos.

**Pigment Orange 46** - Clarion Red offers a brighter and yellower shade of Red Lake C. Properties are similar and caution should be used in plasticized PVC as migration can occur.

**Pigment Red 170** - This Naphthol Red is offered in transparent and opaque versions. The pigments particle size and crystal form control the opacity. The opaque version has a larger particle size. It is yellower in massstone and has better heat/light stability. Naphthol Reds find use in some low cost exterior applications (e.g., coolers) as they have better light stability as compared to metallized azo reds.

**Pigment Red 38** - Pyrazalone Red is ideal for rubber and other low heat applications. The bright, clean red massstone quickly shifts to brown or black at temperatures above 218°C. Alkali resistance is excellent. Pyrazalone Red is FDA approved for use in rubber, under 21CFR Part 178.3297. Table 1 shows the azo reds commonly used in plastics, along with their properties. They are listed from the yellowest to the bluest tint shades.

**Summary**
The azo reds are available in a very wide range of shade from the very yellow shade (orange) to the very blue shade. Generally speaking, they have only modest properties with respect to their light and heat stability. These modest properties are offset by their high tintorial strength and the good economics that they provide when used in plastics applications where their properties are sufficient.

**References**
Heitzman, Scott, Sun Chemical Corp. internal bulletin on pigments for plastics.

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### Azo Reds Commonly Used in Plastics

<table>
<thead>
<tr>
<th>Pigment Type</th>
<th>CI Name</th>
<th>Specific Gravity g/cc</th>
<th>Oil Absorption g/100 grams</th>
<th>Surface Area m²/g</th>
<th>Rubber</th>
<th>PVC</th>
<th>LDPE</th>
<th>PP</th>
<th>PS</th>
<th>ABS</th>
<th>Light MT</th>
<th>Light Tint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarion</td>
<td>P.O. 46</td>
<td>1.7 - 1.8</td>
<td>36 - 45</td>
<td>1 - 100</td>
<td>A</td>
<td>C</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Naphthol</td>
<td>P.R. 170</td>
<td>1.3 - 1.5</td>
<td>10 - 40</td>
<td>n/a</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Red Lake C</td>
<td>P.R. 53:1</td>
<td>1.6 - 2.1</td>
<td>40 - 78</td>
<td>7 - 110</td>
<td>A</td>
<td>C</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Red 2B</td>
<td>P.R. 48:1</td>
<td>1.5 - 2.0</td>
<td>25 - 60</td>
<td>35 - 45</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Pyrazalone</td>
<td>P.R. 38</td>
<td>1.3 - 1.6</td>
<td>41 - 70</td>
<td>n/a</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Red 2B</td>
<td>P.R. 48:2</td>
<td>1.5 - 1.9</td>
<td>35 - 67</td>
<td>50 - 70</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Lithol Red</td>
<td>P.R. 49:1</td>
<td>1.5 - 1.6</td>
<td>40 - 42</td>
<td>n/a</td>
<td>A</td>
<td>C</td>
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<td>B</td>
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<td>B</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Lithol Red</td>
<td>P.R. 49:2</td>
<td>1.5 - 1.7</td>
<td>40 - 55</td>
<td>n/a</td>
<td>A</td>
<td>C</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Pigment Scarlet</td>
<td>P.R. 60:1</td>
<td>2.1 - 2.7</td>
<td>58 - 90</td>
<td>n/a</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Lithol Rubine</td>
<td>P.R. 57:1</td>
<td>1.1 - 1.8</td>
<td>20 - 88</td>
<td>7 - 100</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

A = Generally good properties
B = Possible heat stability problems
C = Possible migration problems
D = Possible migration of carrier resins

*Light - Blue Wool Scale 1-8
n/a = not available

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Since 1938
CRystal Properties of Organic Pigments: The Conclusion

Roger Reinicker, Ciba Specialty Chemicals
Newport, DE

Hue and Particle Size
Due to the effects of absorption and scattering with particle size, changing a pigment's particle size distribution larger or smaller changes its hue. General rules for hue changes with increasing particle size can be stated as follows: larger particle yellows and oranges tend to be redder, yellows tend to become blue, and reds tend to become yellow. Violets to become blue, blues to become redder, and greens to become yellower. The trends do not necessarily follow the shift of hue with colorant concentration. Figure 8 shows the change in hue angle with particle size for three different commercial forms of the diketo-pyrrolopyrrole PR254. The average particle sizes can be inferred from photomicrographs of the to be about 0.1, 0.25, and 0.4 microns from the smallest to the largest. In the figure, the largest particles for this yellow shade red are the bluest and the smallest are yellowest (highest hue angle). Narrower particle size distributions are superior for chrome. Since hue shifts with particle size, it is necessary for the pigment manufacturer to control particle size tightly. Pigments are generally produced in batches and blended both to meet a standard and for uniformity. Blending of wide ranges of particles is actually a blending of different hues and therefore results in loss of chroma.

Morphology and Polymorphism
The structures of organic pigment crystals have become clearer with better understanding of X-ray information and other study techniques, including computational, in recent years. The better fastness properties of some pigments over others can be shown to have a morphological basis. A number of the higher-performing pigments have hydrogen bonding either intramolecularly or intermolecularly within crystal planes of the lattice. Close packing provides further stability. The bonding and structure promotes insolubility and allows the dissipation of energy (light energy, for example) through vibration with eventual loss as heat.

Polymorphism is the existence within a single chemistry of several different crystal types or variations. The most common example of this is the family of copper phthalocyanine blue pigments (PB15) that are formally classified as either 15.1 and 15.2 (alpha crystal or red shade) or 15.3 and 15.4 (beta crystal or green shades). The difference between the crystal types is the lattice spacing of 2.39 nanometers (nm) in alpha blues and 1.94 nm in beta blues. The difference makes the beta blue the more thermodynamically stable of the two types and, given the opportunity and the energy (heat, partial solution) to overcome the barrier to change, the alpha blues will convert to beta. Commercial blue 15:1 pigments are stabilized with chlorine or other additivies on the molecule to help prevent this change. Polymorphism also exists in the unsubstituted quinacridone Pigment Violet 19 but in this case the Colour Index designations do not, unfortunately, differentiate the three major crystal types: alpha, beta and gamma. The beta (violet) and gamma (red) are both commercial. Figure 9 shows other polymorphic pigments. Polymorphism does not necessarily mean large differences among the crystal types; in some cases the colors and properties are quite similar.

Surface Area, Fissuring, and Absorption
Organic pigments are frequently characterized by their surface area. Gas adsorption is the most common method of determination, particularly the Brunauer, Emmet, and Teller (BET) method employing liquid nitrogen or other inert gases. Usually the instruments focus on a single point of the adsorption isotherm instead of the entire isotherm. Figure 10 gives the surface area of a few pigments suitable for use in fiber applications. A comparison is furnished with a common inorganic pigment, red iron oxide (PR101). It is seen that the surface area is a factor of five or ten times lower than the organics. The comparison of the two varieties of the isoindoline yellow underscores the need to understand the composition of the product before interpreting the surface area measurements. The two pigments are essentially equal in both strength and hiding but the one pigment has been rosinated in its process, a common technique for particle size and dispersion control, and reports a much lower value for surface area.

Crystalline pigments can have both openable and rigid pores (or mesopores). If, in BET surface area determinations the pressure is varied (versus a single point determination), curves of the volume of nitrogen absorbed are developed. Hysteresis of these curves (desorption vs. adsorption) and location of the hysteresis (high or low pressure) discloses average pore size, pore size distribution, pore volume, pore type (rigid or openable), and overall pigment surface area.

Our laboratory analyzed two PB15:1 (one a cubic structure and one a media-like) with multipoint analysis (Figures 11 and 12). For comparison, a quinacridone pigment of low hysteresis was also analyzed (Figure 13). Table 4 gives some relevant values for pore volume, pore size, and surface area. The comparison among the three pigments is quite revealing. Pores in the region above P/\rho = 0.4 (where P equals the partial pressure of the adsorbate and \rho equals the saturation equilibrium vapor pressure of the adsorbate) have been characterized as rigid pores. The quinacridone pigment has little hysteresis, low overall surface area, and very few rigid pores. Both blues exhibit significant hysteresis and the presence of rigid pores. The pores are potentially large enough to absorb polymer stabilizers (anti-oxidants, for example) or to import oxygen into polymers if the air was not fully displaced in the dispersion process.

---

Table 4. Pigment Surface Area & Pore Measurements

<table>
<thead>
<tr>
<th>Pigment</th>
<th>Cubic Pore Blue</th>
<th>Needle Pore Blue</th>
<th>PV19 (gammma) Quinacridone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Area, M²/g</td>
<td>60.6</td>
<td>38.8</td>
<td>19</td>
</tr>
<tr>
<td>Average Pore Diameter, Angstroms</td>
<td>133</td>
<td>230</td>
<td>95</td>
</tr>
<tr>
<td>Total Pore Volume, cm³/g</td>
<td>202</td>
<td>224</td>
<td>0.45</td>
</tr>
</tbody>
</table>

---

NUCLEATION

Organic pigments can affect the dynamics of crystallization of semi-crystalline polymers in that the molten polymer on cooling will crystallize at a higher temperature in the presence of some pigments. It seems that the crystalline, but relatively non-polar, surfaces of the pigment crystals initiate alignment of polymer chains and so serve as nucleation sites for the crystallization process. Minimizing this effect can be a challenge, especially for high-density polyethylene due to its very high crystallization kinetics. If crystallization is accelerated, the polymer melt is likely to freeze with the polymer chains still strongly aligned with their flow path. This creates excessive shrinkage in the flow direction, which finally translates, in the case of molding, into deformation of the article. The extent of the deformation is clearly increased if the item has little inherent rigidity (thin walls, no internal reinforcement, etc.).

For polypropylene (PP) injection molding, there is much less of a problem with this nucleation by pigments phenomena due to the overall slower rates of crystallization. In the spinning of PP fibers, however, higher temperatures for crystallization translate into a different distance from the spinneret to the freeze point, altered draw ratios in the molten phase versus natural (or unmodified) polymer, and changed morphological structure. J. Spriewell has demonstrated this phenomenon for a number of pigments (Figure 14), and M. Wishman (Phillips Fibers) has also looked at the crystallization time of a number of pigments in polypropylene (Figure 15), confirming the relationship of organic pigments with accelerated crystallization. Kegel et al examined the nucleation of polypropylene by small amounts of PY109 (isoindolizine), PY19 (quinoxaline) and PG7 (phthalocyanine). In looking at primary crystallization (growth of spherulites) and secondary crystallization (crystallization within the spherulites and in material between spherulites), they discovered differences among the pigments in this regard. The PV19 was found to affect the secondary crystallization and the PG7 the primary crystallization. Several sources cite the ability of PV19 to crystallize a beta-phase (or pseudohexagonal) phase of polypropylene vs. the normal alpha-phase (or monoclinic).

The problems of HDPE molding have led companies to characterization of pigments with regard to distortion (shrinkage and warping) in order to best guide customers in product selection. Also there has come the development of modified forms of organic pigments that reduce or eliminate the distortion in areas of color space where the best offerings from other standpoints (value in use) induce warping. This has occurred with phthalocyanines and PR254 diketo-pyrrolo-pyrrole.

CRYSTAL DESTRUCTION

What happens when the pigment crystal, which is so fundamental to its application properties, is destroyed? Crystals may undergo reaction, be degraded (decomposed), or go into solution. Dissolution usually, but not always, destroys the most useful properties of a pigment. Hue shifts may occur as dissolved species absorb at different wavelengths. Dissolved colorant may migrate (bleed), or quickly fade upon exposure to light. The resultant photo-degraded or photo-activated species may further participate in reactions, possibly de-stabilizing, with other system components. Some dissolved chemistries are strongly fluorescent (quinacridone and perylene, for example).

Solvation requires an aggressive solvent (the polymer), time, high temperatures, and mixing. Virtually every organic pigment can be expected to experience some solubility even in the friendliest polymers. Phthalocyanine blue, for example, is one of the most heat stable organic pigments yet can be shown to be significantly soluble in polyester and a trace soluble in polypropylene. The most aggressive of the common thermoplastic polymers used in synthetic fibers is nylon 66, followed by nylon 6, polyethylene terephthalate, polytrimethylene terephthalate, and finally polypropylene (due to its low temperature of spinning and non-polar nature). The organic pigment palates available for coloring these polymers of course vary with the solubility. Even the most difficult of polymers can be colored with organic pigments through manipulation of the variables affecting solubility, primarily among these being processing time and concentration. In these situations, a small amount of the pigment is sacrificed through dissolution while the remainder of the pigment survives and can be acceptably fast in the application. The dissolved pigment is fugitive (fading rapidly), but the remainder, still in crystalline form, is durable. Testing for pigment suitability in a polymer is usually at a low or intermediate pigment concentration hence higher concentration performance is often overcalled.

CONCLUSIONS

The crystal properties of organic pigments are key to their application. Scattering (hiding) and absorption (strength) are either primary or secondary functions of particle size. Fastness properties are linked to particle size and morphological structure, and size distributions help determine product chroma. Aggregates must be reduced for the pigments to be successful in most plastics and all fiber applications. Fissures and pores in the pigments may affect the stability of polymeric systems by adsorbing either beneficial or detrimental species. Maintenance of the crystal in its intended form preserves the pigments' value-in-use while destruction in processing compromises many of the properties that pigments offer over dyes.

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*Wishman, Marvin, Colossal of Polypropylene Fibers, Fiber Producer, April, 1982


*Kegel et al possibly misidentified the quinacridone in their paper as PR122 (ex. PV19)

*Phthalocyanine blues have a strong absorption band at about 680 nanometers when put into solution. This is accompanied by a green shift in the hue. For this reason, it can be difficult to reproducibly employ phthalocyanine at very low concentrations in polyester fiber.
COUNCILOR'S REPORT

The fall councilor's meeting was held in September 2002. The topics covered included financial discussions, planned outreach programs, award changes and Section/Division news. The budget for 2003 was approved. The details:

FINANCIAL

The 2003 budget was passed at the September Council meeting. It calls for revenues of $7,187,000, with anticipated net revenues of $37,000. It is very conservative and assumes a 22,000 membership base. The anticipated revenue shortfall for 2002 is now about $50,000. Dues will be increased by the automatic cost-of-living formula (1.5% for this year) from $105 to $107. The Finance Committee will recommend that the 2003 Division/Section rebate be paid in two installments.

OUTREACH

SPF will again organize and conduct the seminars at NPE and will be compensated this time. In Europe, SPE has formed an alliance with the British Plastics Federation, similar to the Canadian alliance. Also, a Pan-European newsletter will be launched - 2 issues per year is the goal. In the United States, discussions have been held with the Association of Rotational Molders (ARM) to establish some kind of co-operative relationship with the organization.

PRIDE AWARD CHANGES

There are some changes in the PRIDE Award which are anticipated. These include the acceptance of online as well as printed newsletters, the establishment of a Division membership recognition/awards program, credit for both Fellows and Honored Service Member nominations, and credit for participating in the Newsletter award contest.

Some changes are anticipated in the Outstanding Division Award. These are that the Division must now meet five of the seven criteria used for the award determination, and the ANTEC session criteria have been eliminated. New qualifications are the development of non-North American Session/Division/SIG, implementation of a membership retention and recruitment program, and the addition of two criteria for special awards and student activities.

STUDENT CHAPTERS

ISTIL in Villeurbanne, France has been chartered.

SECTION NAME CHANGE

The Republic of China Section has been renamed the Taiwan Section.

SPECIAL INTEREST GROUPS

The formation of a Plastics Educators SIG was approved. No activity or communication which might be construed as an agreement to refrain from purchasing or using any materials, equipment, services or supplies of or from any supplier; or any other activity which violates antitrust or other applicable laws aimed at preventing unfair competition will be tolerated.

George Rangos

George Rangos

INTRODUCTION OF ANTEC 2003 PLENARY SPEAKERS

The Society of Plastics Engineers presents its 61st Annual Technical Conference (ANTEC)—ANTEC 2003: Plastics Country, USA, in the Nashville Convention Center, Nashville, Tennessee, May 4-8. On Tuesday, May 7, of the world's largest plastics technical conference, at a new time—11:00 a.m. until 12:00 noon, be sure to attend the second plenary session and learn from our guest speaker, Jerry Sturdivant, Body Systems Operations Leader, Saturn Corporation. His presentation is entitled, Got Plastic? Saturn Does!

When Saturn was incorporated in 1985, it was described as a different kind of company and a different kind of car. Since Saturn's beginning, many things have changed within the automotive industry, both internally and externally. Among all these changes, however, one thing has remained constant: Saturn's focus on the customer and the continued use of thermoplastic vertical body panels on all of its vehicles. In addition to manufacturing cars, Saturn now also offers the VUE SUV. Not only does Saturn use plastics for its vehicles, but it has also extended this success to the manufacturing floor. Today's plenary session will focus on just how Saturn "Got Plastic."

Jerry Sturdivant has been with Saturn Corporation since 1986. In his current position as Body Systems Operations Leader for Saturn in Spring Hill, Tennessee, Mr. Sturdivant is responsible for the manufacturing operations involving body fabrication, paint, injection molding of polymer panels, body stamping, adhesives, and coatings. His staff includes eight direct reports with responsibility for approximately 1,300 people.

In addition to being involved in three plant start-ups, Mr. Sturdivant received a U.S. patent for the Integrated Direct Ignition Module, a product that has been used in all GM QUAD IV engines since the 1988 model year. Among his notable and distinguished achievements, Mr. Sturdivant received the Modern Plastics Design of the Year Award for Ignition Module in 1986. In 1991, the SPE Automotive Division presented its prestigious External Panel Design and Grand Design Awards to the Saturn teams, of which he was a participant.

He is a member of both the Ball State University and University of Massachusetts at Lowell Plastics Advisory Boards, the General Motors African Ancestry Executive Council, the Saturn Diversity Strategy Team, and a GM Certified College Recruiter. Mr. Sturdivant holds a Master of Arts degree in Organizational Management (University of Phoenix: Phoenix, Arizona) and a Bachelor of Science degree in Technical Management (Tri-State University: Angola, Indiana).
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